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(54) **Title:** INFRA-RED COMMUNICATION APPARATUS , SYSTEM AND METHOD

(57) **Abstract:** An infra-red port for communicating using infra red to a remote port, the infra-red port comprising: an infra-red receiver for receiving infra red radiation, a modulator, associated with said receiver, for modulating said infra red radiation to carry a communication, and a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said communication to said remote port, thereby passively communicating with said remote port.

INFRA-RED COMMUNICATION APPARATUS, SYSTEM AND METHOD

Field of the Invention

The present invention relates to infra-red communication and more particularly but not exclusively to efficient infra-red communication involving mobile devices.

Background of the Invention

The use of IR communication in portable devices is becoming more popular. Many new devices with IR communication ports are being introduced, among them Palm computers, Cellular telephones, computer keyboards etc. and the number of applications, for such devices, that make use of the IR port are increasing. In many such applications, information download from portable devices to stationary devices is facilitated. Many of the devices using IR communication are portable, which means to say battery powered, devices, rendering it important that the IR port is efficient in its power consumption. Increasing use of IR communication in portable devices, by the various applications increases the importance of low power consumption during communication, thus allowing longer spells of use before having to re-charge the device's batteries.

The standard IR port today comprises one or more IR diodes mounted in the portable device which transmit information using one of the known

communication protocols. Such a means of transmitting is adequate for occasional use, but, as IR transmission using current in the order of milliamps, frequent use of the port may be expected to limit the duration between re-charges. Battery capacity thus acts as a limitation on the freedom of applications to make full use of the IR port.

Summary of the Invention

According to a first aspect of the present invention there is thus provided an infra-red port for communicating using infra red to a remote port, the infra-red port comprising:

an infra-red receiver for receiving infra red radiation,

a modulator, associated with said receiver, for modulating said infra red radiation to carry data, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said modulated radiation to said remote port, thereby passively communicating with said remote port.

The port preferably comprises an infra-red diode for active infra-red transmission.

The port preferably comprises control functionality to initiate communication with a remote port using said infra-red diode and to carry out a

handshake procedure with said remote port to determine whether communication can be continued passively.

Preferably, said handshake procedure is operable to determine whether said remote port belongs to a portable or a fixed device.

Preferably, said handshake procedure is operable to determine, if said remote port belongs to a mobile device, what a current battery power state of said mobile device is.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port has a higher current battery power state.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port is a fixed device.

Preferably, said modulator comprises a capacitive microphone.

Preferably, said modulator comprises a piezoelectric transducer.

Preferably, said reflector comprises a reflecting layer.Alternatively or additionally, said reflector comprises a liquid crystal unit.

Preferably,said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

Preferably, said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

Preferably, said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

Preferably, said piezoelectric actuator is located laterally of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said piezoelectric actuator is arranged to cause bending of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a mirror, and wherein said mirror is located at said focal point.

Preferably, said reflector comprises said mirror and said modulator comprises a control mechanism associated with said mirror for causing vibrations of said mirror.

Preferably, said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

Preferably, said modulator comprises an aperture controller for controlling the aperture of said lens.

Preferably,said aperture controller comprises a first layer having transparent stripes interspersed with absorbing stripes.

Preferably, said aperture controller further comprises a second layer having stripes of absorbing material interspersed with transparent regions, said first and said second layers being superimposed on each other.

Preferably, said aperture controller comprises an LCD unit.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

Preferably, said liquid crystal panel is controllable via associated control circuitry to provide variable reflectance, thereby to provide said modulator.

Preferably, said reflector comprises a corner cube.

Alternatively or additionally, said modulator comprises a MEMS optical switch.

Preferably, said MEMS optical switch is a thermal effect MEMS optical switch.

Alternatively or additionally, said MEMS optical switch is an electrostatic force MEMS optical switch.

Preferably, said reflector comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, and said modulator comprises control circuitry associated with said panel to rearrange said patterns.

The port preferably is operable to be used in data recording.

The port may be located in a sensor device, for providing communication between said sensor device and said remote port.

The sensor device may be an elongated marker type sensor device.

According to a second aspect of the present invention there is provided a passive infra-red detection port for scanning a region, the infra-red port comprising:

an infra-red receiver for receiving infra red radiation from an external source,

a modulator, associated with said receiver, for modulating said infra red radiation to detect intrusion events, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to scan said region.

The port preferably comprises an active detection IR emitter for emitting short IR pulses and further comprising a detector for detecting the reflected signal.

Preferably, said reflector comprises a scanning mirror for scanning said beam over a predetermined arc.

Preferably, said modulator is operable to modulate said beam to a frequency of substantially 10Hz.

According to a third aspect of the present invention there is provided an infra-red communication system for providing communication between at least a first device and a second device, each device comprising an infra-red communication port, at least the communication port of the first device comprising:

an infra-red receiver for receiving infra red radiation,

a modulator, associated with said receiver, for modulating said infra red radiation to carry a data, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said data to said remote port, thereby passively communicating with the communication port of the second device.

Preferably, at least one of said communication ports further comprises an infra-red diode for active infra-red transmission.

Preferably, at least one of said communication ports comprises control functionality to initiate communication with said other port using said infra-red diode and to carry out a handshake procedure with said other port to determine whether communication can be continued passively.

Preferably, said handshake procedure is operable to determine whether said other port belongs to a portable or a fixed device.

Preferably, said handshake procedure is operable to determine, if said other port belongs to a mobile device, what a current power state of said mobile device is.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said other port has a higher current power state.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of said ports is associated with a fixed device.

Preferably, said modulator comprises a capacitive microphone.

Alternatively or additionally, said modulator comprises a piezoelectric transducer.

Preferably, said reflector comprises a reflecting layer.

Alternatively or additionally, said reflector comprises a liquid crystal layer.

Preferably, said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

Preferably, said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

Preferably, said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

Preferably, said piezoelectric actuator is located laterally of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said piezoelectric actuator is arranged to cause bending of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said receiver, and said reflector together comprise a lens having a focal point and a mirror and wherein said mirror is located at said focal point.

Preferably, said reflector comprises said mirror, and said modulator comprises control circuitry associated with an actuator to vibrate said mirror.

Preferably, said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

Preferably, said modulator comprises an aperture control mechanism associated with said lens.

Preferably, said receiver, and said reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

Preferably, said liquid crystal panel is controllable to provide variable reflectance, thereby to provide said modulator.

Preferably, said reflector comprises a corner cube.

Alternatively or additionally, said modulator comprises a MEMS optical switch.

Preferably, said MEMS optical switch is a thermal effect MEMS optical switch.

Alternatively or additionally, said MEMS optical switch is an electrostatic force MEMS optical switch.

Preferably, said reflector comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, and said modulator comprises control circuitry associated with said panel to rearrange said patterns.

Preferably, one of said devices is a sensor device, and another of said devices comprises sensor processing functionality.

According to a fourth aspect of the present invention there is provided an infra-red communication method comprising:

sending an infra red beam from a first location,

receiving said beam at a second location,

modulating said beam at said second location to add information content to said beam, and

reflecting said modulated beam.

The method preferably further comprises receiving said modulated beam at said first location.

The method preferably further comprises receiving said modulated beam at a third location.

Preferably, said modulating comprises changing a level of reflectance spatially over said beam.

Preferably, said modulating comprises changing a level of reflectance temporally in said beam.

The method preferably further comprises a handshake procedure of determining at one of said locations whether to operate as a beam source or as a beam reflector.

Preferably, said handshake procedure comprises basing said determination on which of said locations has a less energized power supply.

Preferably, said first location comprises a control device and said second location comprises a remote sensor.

Preferably, modulating said beam comprises dynamically altering a reflectance level of a surface on which said beam is incident.

Preferably, modulating said beam comprises dynamically vibrating a surface on which said beam is incident.

Preferably, modulation is controllable to carry data according to the Bluetooth protocol.

Alternatively or additionally, the modulation is controllable to carry data according to the IrDA protocol.

According to a fifth aspect of the present invention there is provided a passive infra-red communication method comprising:

receiving an infra red beam from an external location,

modulating said infra-red beam to add information content to said beam, and

reflecting said modulated beam.

Preferably, said reflecting comprises directing said beam at said external location.

Preferably, said reflecting comprises directing said modulated beam at a third location.

Preferably, said modulating comprises changing a level of reflectance spatially over said beam.

Preferably, said modulating comprises changing a level of reflectance temporally in said beam.

The method preferably further comprises an initializing procedure of:

carrying out a handshake with said external location, and

determining, from results of said handshake, whether to continue with said method.

Preferably, said handshake procedure comprises basing said determination on a comparison of power supply states with said external location.

Preferably, modulating said beam comprises dynamically altering a reflectance level of a surface on which said beam is incident.

The method preferably further comprises modulating said beam by dynamically vibrating a surface on which said beam is incident.

Preferably, said modulation is controllable to carry data according to the Bluetooth protocol.

Alternatively or additionally, said modulation is controllable to carry data according to the IrDA protocol.

According to a sixth aspect of the present invention there is provided a passive modulator and retro-reflector comprising:

a beam receiver for receiving an external beam,

a beam modulator located downstream of said beam receiver for modulating said externally received beam, and

a retro –reflector for retro-reflecting said modulated beam back via said beam receiver.

The device is prefearbly tunable for an infra-red beam.

Preferably, the device further comprises an infra-red diode for active infra-red transmission.

The device preferably comprises control functionality to initiate communication with a remote port using said infra-red diode and to carry out a handshake procedure with said remote port to determine whether communication can be continued passively.

Preferably, said handshake procedure is operable to determine whether said remote port belongs to a portable or a fixed device.

Preferably, said handshake procedure is operable to determine, if said remote port belongs to a mobile device, what a current power state of said mobile device is.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-

red port and the device associated with said remote port has a higher current power state.

Preferably, said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port is a fixed device.

Preferably, said modulator comprises a capacitive microphone.

Alternatively or additionally, said modulator comprises a piezoelectric transducer.

Preferably, said retro-reflector comprises a reflecting layer.

Alternatively or additionally, said retro-reflector comprises a liquid crystal layer.

Preferably, said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

Preferably, said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

Preferably, said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

Preferably, said piezoelectric actuator is located laterally of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said piezoelectric actuator is arranged to cause bending of said one of said layers.

Preferably, said piezoelectric actuator is associated with said reflecting layer.

Preferably, said receiver, and said retro-reflector together comprise a lens having a focal point, and a mirror, and wherein said mirror is located at said focal point.

Preferably, said retro-reflector comprises said mirror and said modulator comprises a control mechanism associated with said mirror for causing vibrations of said mirror.

Preferably, said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

Preferably, said modulator comprises an aperture controller for controlling the aperture of said lens.

Preferably, said aperture controller comprises a first layer having stripes of transparent material interspersed with absorbing material.

Preferably, said aperture controller further comprises a second layer having stripes of non-reflecting material interspersed with transparent regions, said first and said second layers being superimposed on each other.

Preferably, said aperture controller comprises an LCD unit.

Preferably, said receiver, and said retro-reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

Preferably, said modulator comprises control circuitry associated with said LCD panel to provide variable reflectance in said modulator.

Preferably, said retro-reflector comprises a corner cube.

Alternatively or additionally, said modulator comprises a MEMS optical switch.

Preferably, said MEMS optical switch is a thermal effect MEMS optical switch.

Alternatively or additionally, said MEMS optical switch is an electrostatic force MEMS optical switch.

Preferably, said modulator comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, said panel being controllable to rearrange said patterns.

The device may for example be located in a sensor device, for providing communication between said sensor device and said remote port.

Such a sensor device may be an elongated marker type sensor device.

According to a seventh aspect of the present invention there is provided an infra-red based remote control unit for remotely controlling a device, the unit comprising:

an infra-red receiver for receiving infra red radiation from said device,

a modulator, associated with said receiver, for modulating said infra red radiation with control data for said device, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said modulated radiation to said device, thereby to passively control said device.

According to an eighth aspect of the present invention there is provided an infra-red relay unit for relaying a communicating using infra red to a remote port, the infra-red relay unit comprising:

an infra-red receiver for receiving modulated infra red radiation from one source and unmodulated infrared radiation from another source,

a modulator, associated with said receiver, for modulating said unmodulated infra red radiation with data carried by said modulated radiation to form a relay beam, and

a reflector, associated with said modulator, for redirecting said relay beam to carry said modulated radiation to said remote port, thereby providing a passive relay link.

Brief Description of the Drawings

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, purely by way of example, to the accompanying drawings.

With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. In the accompanying drawings:

Fig. 1 is a simplified block diagram showing an office with IR capability for communicating with mobile devices according to a first preferred embodiment of the present invention,

Fig. 2 is a simplified block diagram of an IR port according to a preferred embodiment of the present invention,

Fig. 3 is a simplified block diagram of another IR port according to a preferred embodiment of the present invention,

Fig. 4 is a simplified block diagram of an IR port having handshake control according to a preferred embodiment of the present invention,

Fig. 5 is a simplified schematic diagram of an IR communication channel using a PMRF mode according to a preferred embodiment of the present invention,

Fig. 6 is a simplified schematic diagram of a modulation device according to a preferred embodiment of the present invention,

Fig. 7 is a simplified schematic diagram showing construction details of internal layers of a modulation device according to a preferred embodiment of the present invention,

Fig. 8 is a simplified schematic diagram of a palm marker type sensor operative in accordance with a preferred embodiment of the present invention,

Fig. 9 is a simplified schematic diagram showing a modification of an IR port according to a preferred embodiment of the present invention for use as a security sensor, and

Fig. 10 is a simplified flow chart showing a procedure for carrying out passive communication according to a preferred embodiment of the present invention.

Description of the Preferred Embodiments

Embodiments of the present invention provide a method and apparatus for providing IR communication channels which use passive modulation with retro-reflection (PMRF). An IR source for communication is preferably located in a stationary or mains operated device, for example a fixed Bluetooth or IrDA unit for example in an office, or at a pay in kiosk or a terminal for downloading information from the portable device. In the office mode, for example the IR source is mounted in a central location in a room, such as the ceiling, allowing communication between all devices equipped with the PMRF technology. The IR radiation is modulated by the portable device and the modulated information is retro-reflected to the stationary device where it is detected and decoded, thereby providing a two way IR communication channel in which only one of the devices needs to provide an active IR source. The advantage of the PMRF technique is that the energy required to modulate the IR beam is much lower than the energy required to transmit the IR beam. The useful battery life of the portable device is thus considerably extended. Thus,whereas active IR communication consumes milliamperes of current, passive modulation as will be described hereinbelow may consume current in the microamperes range.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is applicable to other embodiments or of being practiced or carried out in various ways.

Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

Reference is now made to Fig. 1, which is a simplified block diagram showing an infra-red communication link according to a first preferred embodiment of the present invention. In the embodiment of Fig. 1, a central IR communication unit 10 is located in a convenient location of an office for line of sight connection throughout the office. Such a central unit 10 may preferably be located in the ceiling. Two remote devices 12 and 14 are located in the office and have line of sight connection to the central unit 10. The central unit 10 thus connects the remote devices to each other and to any other devices linked to the central unit, thereby providing a flexible intranet. The remote connection is made using IR radiation and conventional IR connections have the disadvantage of high battery drain on mobile devices. As shown in Fig. 1 however, the only device that uses active IR signal generation is the central unit 10. The other devices 12 and 14 do not generate their own IR source but rather use passive modulation with retro reflection, which is to say that they modulate and reflect IR radiation from the central unit 10, as will be explained in more detail below.

Reference is now made to Fig. 2, which is a simplified block diagram showing a preferred embodiment of an IR port suitable for use in the devices 12 and 14 of Fig. 1. In Fig. 2 an IR port 16 comprises an infra-red receiver 18 for receiving infra red radiation, a modulator 20 (connected to the receiver in case of a relay mode of operation), for modulating the infra red radiation to

carry data, and a reflector 22, connected to the modulator, for redirecting the modulated infra-red radiation to carry the communication to a remote port. The arrangement described above allows passive communication with the remote port, which is to say that incoming communication data is detected by the receiver and outgoing communication data is modulated onto an externally produced IR signal which is then reflected to the communication target, generally but not necessarily the same place as the source of the IR beam.

It is noted that the port has two modes of operation, a mode of modulation of the retro-reflected beam by the data back to the source of the beam; and a relay mode in which the receiver detects an IR signal carrying information, sends the information to the modulator which modulates it on to another beam which is retro-reflected.

As will be explained below, the reflector, modulator and reflector may be physically embodied as three or more separate components, or two separate components or as a single component carrying out all of the functions.

Reference is now made to Fig. 3, which shows an alternative embodiment of the infra-red port of Fig. 2. Parts that appear in earlier figures are given the same reference numerals and are not discussed in detail again except as needed for an understanding of the present embodiment. An infra-red port 24 comprises the same receiver, modulator and reflector as in that of Fig. 2 but additionally comprises an active IR diode for active infra-red transmission. The diode may be used to provide an active IR source for data transmission, so that the port may be used, for example, to initiate communication, or in any

other circumstances when passive communication is judged not to be optimal, as will be discussed in greater detail below.

Reference is now made to Fig. 4, which is a simplified block diagram showing an IR port of the kind shown in Fig. 3 associated with handshake control functionality. The IR port of Fig. 4 is able to operate in both passive and active modes. The handshake control allows the port to take different circumstances into account in deciding which mode to select. For example if the port is attached to a fixed device, that is a device attached to mains power then the port would usually wish to operate actively, since power usage is not a matter of concern. If the port is attached to a mobile, that is battery powered, device then it may normally wish to operate in passive mode in order to save power. If however it is attached to a mobile device and is also communicating with a mobile device, then the handshake procedure may allow for the two devices to negotiate which has the lower battery charge. The device determined to be operating with the lower charge may be set to operate in passive mode. The handshake controller thus allows the device to interrogate another device with which it is communicating to determine whether active or passive communication is the most suitable mode in the circumstances.

The handshake procedure may thus include functionality to determine whether the remote port belongs to a portable or a fixed device. If the remote port belongs to a fixed device and the present device is a portable device then the remote port is told to communicate actively and the present device is told to communicate passively. If both devices are portable devices then preferably a

further stage in the handshake procedure determines which of the devices has the lower power level or lower power reliability and selects that device as the passive communicator. If both devices are fixed devices then either both devices can communicate actively or one of the devices is selected by default as the passive communicator.

Typically, such a handshake may comprise a device ID from the initiating device, followed by each device revealing whether it is mains or battery powered followed by battery powered devices indicating their battery status. Based on the information exchanged, either the initiating or receiving device as desired may decide which of the devices is to be the active communicator. The handshake stage is preferably completed rapidly and one of the devices is then able to enter passive mode.

In the type of scenario shown in Fig. 1, the central unit may routinely transmit IR signals, simply allowing all responding devices to be in passive mode.

Reference is now made to Fig. 5, which is a simplified block diagram of a communication channel between active and passive infra-red ports. An active IR port 32 comprises an IR source 34 and an IR detector 36. A passive IR port 38 is in line of sight relationship with the active IR port 32 and comprises a lens 40 for focusing incoming IR radiation and a modulator/reflector 42 for modulating the IR with data and reflecting modulated IR back to the active IR port 32.

In operation, the IR source 34 produces IR radiation which is emitted in the direction of the passive port 38. The radiation is focused by the lens 40 onto the modulator/reflector 42 which may then modulate data onto the IR beam prior to reflecting it back to the active IR port 32. Thus the passive port 38 is able to transmit data whilst substantially relying on the energy of the active port 32.

It will be appreciated by the skilled person that there are a large number of ways in which modulation of the IR beam may be carried out. For the purposes of the present invention it is preferable to consider methods in which the current required to drive the modulation may be kept to the microampere order of magnitude.

Reference is now made to Fig. 6, which is a simplified schematic diagram showing a first preferred embodiment of an infra-red port able to modulate an IR beam. Parts that appear in earlier figures are given the same reference numerals and are not discussed in detail again except as needed for an understanding of the present embodiment. In Fig. 6, an infra-red port comprises a lens 40 for receiving an incoming beam, and a modulator/reflector 42 located at the focus of lens 40. The modulator/reflector retro reflects incident IR back to the source. Modulation of the light may be achieved using a variety of techniques including spatial motion of the reflector in the lateral or focus directions, thus changing the amount of energy retro-reflected, polarization modulation to change the effective reflectance, changing of the lens aperture (so that the lens serves as the modulator) and using a liquid

crystal with changing reflectivity as the reflector. Motion based modulation may typically be achieved using a piezoelectric layer. One preferred embodiment of a motion based modulator is shown schematically in Fig. 7. In Fig. 7 two layers are shown, a front layer 44 and a back layer 46. The front layer 44 comprises a series of non-reflecting stripes 48 interspersed with transparent regions 50. The back layer 46 comprises a series of reflecting stripes 52 interspersed by non-reflecting regions 54. Preferably the geometries of the stripes and intervening regions in the two layers are substantially identical. In use the two layers are superimposed and at least one of the layers is mobile. The layers preferably take two relative positions, a maximum reflectance position in which the reflecting stripes 52 of the back layer 46 coincide with the transparent regions 50 of the front layer 44, and a minimum reflectance position in which the non-reflecting regions 54 of the back layer 46 coincide with the transparent regions 50 of the front layer 44. The reflector/modulator 42 thus serves as a binary modulation system. The amount of energy needed to carry out the modulation is minimal since the total motion that is needed is that of the width of the stripes. That is to say a high modulation range is achievable using motion which is very much smaller than the field of view of the device or its depth of focus. The extent of motion can be minimized to the extent that it is possible to minimize the stripes and still be able to control their registration. Motion may be provided by attaching a piezoelectric actuator to one of the layers. Such actuators are able to provide sub-millisecond response times.

A variation on the above approach is to provide the back layer 46 with a piezoelectric bending device. Bending of the back layer rather than moving it from side to side causes the desired modulation. An advantage of the piezoelectric bending device is that the actuator may be placed in line with the lens and reflector and thus the footprint of the device as a whole is reduced. By contrast, for lateral movement of one of the surfaces, a piezoelectric transducer is preferably attached to a lateral side of the surface, thereby increasing the lateral footprint.

Further methods of modulation include using mirrors mounted on chips, available in array form, and MEMS optical switches. The MEMS optical switches include both thermal effect and electrostatic force based switches it is expected that other MEMS techniques could be used as well.

Referring again to Fig. 7, and a further alternative is to replace the back layer 46 with an LCD panel. The panel may then be activated to produce the same kind of stripes as before, thereby to modulate the signal. The stripes can then be electronically moved across the liquid crystal. Using liquid crystal modulation avoids mechanical motion and thus is even less power consuming. Furthermore it offers wider bandwidth. A single liquid crystal activated or deactivated as a single body is also a possibility. Miniature optical switches based on liquid crystal are available from several sources including 3M, and switching speeds of 100kHz may currently be achieved.

A capacitive microphone is another modulation technique. Applying voltage across a vacuum capacitor yields the required modulation. Bandwidth higher than 20 kHz may be attained in this manner.

In a further embodiment, the modulator comprises polarizing filters located in front of the mirror 42. The polarizers are preferably rotatable and can be used to alter the amount of reflected radiation emitted.

In a further alternative embodiment, the reflector/modulator is a corner cube.

As referred to in respect of Fig. 1, an arrangement according to the present invention may provide the infrastructure for a flexible local intranet, typically using the Bluetooth protocol (or IrDA) on an IR link with central unit 10 providing connectivity for the entire space. Using passive communication and the PMRF technique, it is possible for portable devices to operate infra-red communication links using microwatt power levels as opposed to the milliwatts required by prior art methods. It is therefore feasible for small devices such as cellular phones and PDAs to benefit from being connected to the local intranet without their power usage being greatly affected.

Reference is now made to Fig. 8, which is a schematic block diagram showing a sensor device according to a further preferred embodiment of the present invention. In the embodiment of Fig. 8, a sensor device 60 comprises sensing circuitry 62, processing capacity 64 and a piezoelectric device 66 (or other modulation techniqu). Data is obtained by the sensing circuitry 62,

processed by the processor 64 and modulated by the piezoelectric device onto an incident IR beam using the PMRF technique discussed above. The sensor may be used as a remote station in line of site communication with a central controller which may be the central unit 10 of a Bluetooth or IrDA based intranet or it may be PDA or palmtop or any other device capable of controlling or monitoring a sensor. The sensor thus operates with considerably reduced battery consumption.

In a preferred embodiment the remote sensor 60 is configured in the shape of the standard Palm marker, and such a configuration is shown in Fig. 8. In order to produce the marker configuration, space is of high importance and the PMRF technique is valuable since it has a narrow footprint. When the remote sensor 60 uses the PMRF modulation technique, the PDA itself functions as the stationary device, using its active IR source to establish and maintain the communication link.

The interface of the remote sensor to the Palm may be via direct link, diffused reflection or specular reflection. The remote sensor preferably has data storage capabilities and hence can download the stored data when it is interfaced to the PDA docking station.

A few examples of remote sensor applications include temperature measurement, acoustic sensing, video photography, security sensing, and various types of medical sensing.

An advantage of the PDA and remote sensor embodiment lies in the ability to interface new sensors to the standard PDA without changing the basic architecture. The ability of the sensor to operate remotely with no cable interface is advantageous in many circumstances, for example where small dimensions and compactness are important, including where invisibility of the sensor is required.

It will be appreciated that the remote device need not be a sensor, but could also be any other device that may be remotely communicated with using an IR link by the PDA or central unit, such as a printer, cellular phone, laptop computer etc.

Reference is now made to Fig. 9, which is a simplified diagram showing an embodiment of the present invention for security sensing. In the embodiment of Fig. 9, a PDA 70 or any other device is provided with an IR port 72 capable of using PRMF techniques. The port 72 is shown enlarged in the lower part of the figure. The port comprises an active or passive IR source 74. In the case of a passive IR source, that means that an IR beam is obtained from another active device. A a wide field of view beam covers a space over which detection is required. Preferably the IR beam is emitted at a frequency which is considerably higher than any of the intrusion events it is desired to detect. – typically 10Hz at with very short pulse duration, so consumption is minimal. An algorithm in the PDA or palmtop may analyze the detected signal. A change in the pattern of the detected signal generally indicates a change in the near environment of the Palm. Such a change in a room where no motion is

supposed to occur is an indication of an intruder. Another embodiment is with a scanning mirror to facilitate a wider field of view.

One preferred embodiment uses such a security mode when the palm is positioned in its docking station. The security mode may ensure that nobody attempts to take the device and download confidential information.

Two preferred options are available for scanning the detection beam, volumetric coverage, for cases where intruders can be expected from a wide angle, or linear coverage, where there is a clear direction from which the intruder can arrive. The selection between the two modes may affect the type of optics used.

It will be appreciated that the wide bandwidth available can also be used for general IR signal transmission, downloading and data recording. Data can be encoded and subsequently decoded as necessary.

In a preferred embodiment, PMRF can be used in a relay to overcome range and line of sight limitations.

A particularly preferred embodiment of the present invention involves IR based remote control devices. PMRF, which uses microamps of current, allows a remote control device to run indefinitely on a single battery. Likewise the battery may be smaller, allowing the remote control device itself to be smaller and lighter.

Reference is now made to Fig. 10, which is a simplified flow chart of a passive communication method in accordance with a preferred embodiment of the present invention.

The method begins with initiation of the communication, by either the local or a remote port. Generally initiation is carried out actively. The exception, as mentioned above, is the case of a central unit permanently monitoring for devices in a space such as an office, where the devices in the office may initiate communication passively by responding to a monitoring beam. Initiation is preferably followed by a handshake procedure in which the local and remote port negotiate which is to be the passive and which the active communicator. The handshake procedure is preferably dispensed with in cases such as that of the central unit, which is set up as a default active communicator. As mentioned above, the handshake procedure generally selects the device having the better or more reliable power supply as the active communicator and the device having the weaker or less reliable power supply as the passive communicator.

If the local device is set up as the active communicator then it proceeds to communicate actively in the normal way, as in the prior art by producing an infra red beam from an internal IR diode or the like. Data is then modulated onto the IR beam for communication. In addition the active communicator continues to produce and send the IR beam even when there is no data to modulate thereon so that the passive device can use the beam.

If the local device is set up, by the handshake procedure or otherwise, as the passive communicator, then the system waits until a beam is received from the remote device. The received beam is modulated with data to be communicated, using any of the methods described above or other methods as deemed appropriate by the skilled person, and the beam is reflected for output.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined by the appended claims and includes both combinations and subcombinations of the various features described hereinabove as well as variations and modifications thereof which would occur to persons skilled in the art upon reading the foregoing description.

Claims

1. An infra-red port for communicating using infra red to a remote port, the infra-red port comprising:

an infra-red receiver for receiving infra red radiation,

a modulator, associated with said receiver, for modulating said infra red radiation to carry data, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said modulated radiation to said remote port, thereby passively communicating with said remote port.

2. The infra-red port of claim 1, further comprising an infra-red diode for active infra-red transmission.

3. The infra-red port of claim 2, comprising control functionality to initiate communication with a remote port using said infra-red diode and to carry out a handshake procedure with said remote port to determine whether communication can be continued passively.

4. The infra-red port of claim 3, wherein said handshake procedure is operable to determine whether said remote port belongs to a portable or a fixed device.

5. The infra-red port of claim 4, wherein said handshake procedure is operable to determine, if said remote port belongs to a mobile device, what a current battery power state of said mobile device is.

6. The infra-red port of claim 5, wherein said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port has a higher current battery power state.

7. The infra-red port of claim 4, wherein said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port is a fixed device.

8. The infra-red port of claim 1, wherein said modulator comprises a capacitive microphone.

9. The infra-red port of claim 1, wherein said modulator comprises a piezoelectric transducer.

10. The infra-red port of claim 1, wherein said reflector comprises a reflecting layer.

11. The infra-red port of claim 1, wherein said reflector comprises a liquid crystal unit.

12. The infra-red port of claim 10, wherein said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

13. The infra-red port of claim 10, wherein said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

14. The infra-red port of claim 13, wherein said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

15. The infra-red port of claim 14, wherein said piezoelectric actuator is located laterally of said one of said layers.

16. The infra-red port of claim 14, wherein said piezoelectric actuator is associated with said reflecting layer.

17. The infra-red port of claim 14, wherein said piezoelectric actuator is arranged to cause bending of said one of said layers.

18. The infra-red port of claim 17, wherein said piezoelectric actuator is associated with said reflecting layer.

19. The infra-red port of claim 1, wherein said receiver, and said reflector together comprise a lens having a focal point, and a mirror, and wherein said mirror is located at said focal point.

20. The infra-red port of claim 19, wherein said reflector comprises said mirror and said modulator comprises a control mechanism associated with said mirror for causing vibrations of said mirror.

21. The infra-red port of claim 19, wherein said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

22. The infra-red port of claim 19, wherein said modulator comprises an aperture controller for controlling the aperture of said lens.

23. The infra-red port of claim 22, wherein said aperture controller comprises a first layer having transparent stripes interspersed with absorbing stripes.

24. The infra-red port of claim 23, wherein said aperture controller further comprises a second layer having stripes of absorbing material interspersed with transparent regions, said first and said second layers being superimposed on each other.

25. The infra-red port of claim 22 wherein said aperture controller comprises an LCD unit.

26. The infra-red port of claim 1, wherein said receiver, and said reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

27. The infra-red port of claim 26, wherein said liquid crystal panel is controllable via associated control circuitry to provide variable reflectance, thereby to provide said modulator.

28. The infra-red port of claim 1, wherein said reflector comprises a corner cube.

29. The infra-red port of claim 1, wherein said modulator comprises a MEMS optical switch.

30. The infra-red port of claim 29, wherein said MEMS optical switch is a thermal effect MEMS optical switch.

31. The infra-red port of claim 29, wherein said MEMS optical switch is an electrostatic force MEMS optical switch.

32. The infra-red port of claim 1, wherein said reflector comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, and said modulator comprises control circuitry associated with said panel to rearrange said patterns.

33. The infra-red port of claim 1, operable to be used in data recording.

34. The infra-red port of claim 1, located in a sensor device, for providing communication between said sensor device and said remote port.

35. The infra-red port of claim 34, said sensor device being an elongated marker type sensor device.

36. A passive infra-red detection port for scanning a region, the infra-red port comprising:

an infra-red receiver for receiving infra red radiation from an external source,

a modulator, associated with said receiver, for modulating said infra red radiation to detect intrusion events, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to scan said region.

37. The passive infra-red detection port of claim 36 further having an active detection IR emitter for emitting short IR pulses and further comprising a detector for detecting the reflected signal.

38. The infra-red port of claim 36, wherein said reflector comprises a scanning mirror for scanning said beam over a predetermined arc.

39. The infra-red port of claim 36, wherein said modulator is operable to modulate said beam to a frequency of substantially 10Hz.

40. An infra-red communication system for providing communication between at least a first device and a second device, each device comprising an infra-red communication port, at least the communication port of the first device comprising:

an infra-red receiver for receiving infra red radiation,

a modulator, associated with said receiver, for modulating said infra red radiation to carry a data, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said data to said remote port, thereby passively communicating with the communication port of the second device.

41. The infra-red communication system of claim 40, wherein at least one of said communication ports further comprises an infra-red diode for active infra-red transmission.

42. The infra-red communication system of claim 41, wherein at least one of said communication ports comprises control functionality to initiate communication with said other port using said infra-red diode and to carry out a handshake procedure with said other port to determine whether communication can be continued passively.

43. The infra-red communication system of claim 42, wherein said handshake procedure is operable to determine whether said other port belongs to a portable or a fixed device.

44. The infra-red communication system of claim 43, wherein said handshake procedure is operable to determine, if said other port belongs to a mobile device, what a current power state of said mobile device is.

45. The infra-red communication system of claim 44, wherein said control functionality is operable to assign a role of active communicator to

whichever one of a device associated with said infra-red port and the device associated with said other port has a higher current power state.

46. The infra-red communication system of claim 43, wherein said control functionality is operable to assign a role of active communicator to whichever one of said ports is associated with a fixed device.

47. The infra-red communication system of claim 40, wherein said modulator comprises a capacitive microphone.

48. The infra-red communication system of claim 40, wherein said modulator comprises a piezoelectric transducer.

49. The infra-red communication system of claim 40, wherein said reflector comprises a reflecting layer.

50. The infra-red communication system of claim 40, wherein said reflector comprises a liquid crystal layer.

51. The infra-red communication system of claim 49, wherein said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

52. The infra-red communication system of claim 49, wherein said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

53. The infra-red communication system of claim 52, wherein said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

54. The infra-red communication system of claim 53, wherein said piezoelectric actuator is located laterally of said one of said layers.

55. The infra-red communication system of claim 53, wherein said piezoelectric actuator is associated with said reflecting layer.

56. The infra-red communication system of claim 53, wherein said piezoelectric actuator is arranged to cause bending of said one of said layers.

57. The infra-red communication system of claim 56, wherein said piezoelectric actuator is associated with said reflecting layer.

58. The infra-red communication system of claim 40, wherein said receiver, and said reflector together comprise a lens having a focal point and a mirror and wherein said mirror is located at said focal point.

59. The infra-red communication system of claim 58, wherein said reflector comprises said mirror, and said modulator comprises control circuitry associated with an actuator to vibrate said mirror.

60. The infra-red communication system of claim 58, wherein said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

61. The infra-red communication system of claim 58, wherein said modulator comprises an aperture control mechanism associated with said lens.

62. The infra-red communication system of claim 40, wherein said receiver, and said reflector together comprise a lens having a focal point,

and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

63. The infra-red communication system of claim 62, wherein said liquid crystal panel is controllable to provide variable reflectance, thereby to provide said modulator.

64. The infra-red communication system of claim 40, wherein said reflector comprises a corner cube.

65. The infra-red communication system of claim 40, wherein said modulator comprises a MEMS optical switch.

66. The infra-red communication system of claim 65, wherein said MEMS optical switch is a thermal effect MEMS optical switch.

67. The infra-red communication system of claim 65, wherein said MEMS optical switch is an electrostatic force MEMS optical switch.

68. The infra-red communication system of claim 40, wherein said reflector comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, and said modulator comprises control circuitry associated with said panel to rearrange said patterns.

69. The infra-red communication system of claim 40, wherein one of said devices is a sensor device, and another of said devices comprises sensor processing functionality.

70. An infra-red communication method comprising:

sending an infra red beam from a first location,

receiving said beam at a second location,

modulating said beam at said second location to add information content to said beam, and

reflecting said modulated beam.

71. The method of claim 70, further comprising receiving said modulated beam at said first location.

72. The method of claim 70, further comprising receiving said modulated beam at a third location.

73. The method of claim 70, wherein said modulating comprises changing a level of reflectance spatially over said beam.

74. The method of claim 70, wherein said modulating comprises changing a level of reflectance temporally in said beam.

75. The method of claim 70, further comprising a handshake procedure of determining at one of said locations whether to operate as a beam source or as a beam reflector.

76. The method of claim 75, wherein said handshake procedure comprises basing said determination on which of said locations has a less energized power supply.

77. The method of claim 70, wherein said first location comprises a control device and said second location comprises a remote sensor.

78. The method of claim 70, wherein modulating said beam comprises dynamically altering a reflectance level of a surface on which said beam is incident.

79. The method of claim 70, wherein modulating said beam comprises dynamically vibrating a surface on which said beam is incident.

80. The method of claim 70, said modulation being controllable to carry data according to the Bluetooth protocol.

81. The method of claim 70, said modulation being controllable to carry data according to the IrDA protocol.

82. A passive infra-red communication method comprising:

receiving an infra red beam from an external location,

modulating said infra-red beam to add information content to said beam, and

reflecting said modulated beam.

83. The method of claim 82, wherein said reflecting comprises directing said beam at said external location.

84. The method of claim 82, wherein said reflecting comprises directing said modulated beam at a third location,

85. The method of claim 82, wherein said modulating comprises changing a level of reflectance spatially over said beam.

86. The method of claim 82, wherein said modulating comprises changing a level of reflectance temporally in said beam.

87. The method of claim 82, further comprising an initializing procedure of:

carrying out a handshake with said external location, and

determining, from results of said handshake, whether to continue with said method.

88. The method of claim 87, wherein said handshake procedure comprises basing said determination on a comparison of power supply states with said external location.

89. The method of claim 82, wherein modulating said beam comprises dynamically altering a reflectance level of a surface on which said beam is incident.

90. The method of claim 82, wherein modulating said beam comprises dynamically vibrating a surface on which said beam is incident.

91. The method of claim 82, said modulation being controllable to carry data according to the Bluetooth protocol.

92. The method of claim 82, said modulation being controllable to carry data according to the IrDA protocol.

93. A passive modulator and retro-reflector comprising:

a beam receiver for receiving an external beam,

a beam modulator located downstream of said beam receiver for modulating said externally received beam, and

a retro –reflector for retro-reflecting said modulated beam back via said beam receiver.

94. The passive modulator and retro-reflector of claim 93, being tunable for an infra-red beam.

95. The passive modulator and retro-reflector of claim 93, further comprising an infra-red diode for active infra-red transmission.

96. The passive modulator and retro-reflector of claim 95, comprising control functionality to initiate communication with a remote port using said infra-red diode and to carry out a handshake procedure with said remote port to determine whether communication can be continued passively.

97. The passive modulator and retro-reflector of claim 96, wherein said handshake procedure is operable to determine whether said remote port belongs to a portable or a fixed device.

98. The passive modulator and retro-reflector of claim 97, wherein said handshake procedure is operable to determine, if said remote port belongs to a mobile device, what a current power state of said mobile device is.

99. The passive modulator and retro-reflector of claim 98, wherein said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port has a higher current power state.

100. The passive modulator and retro-reflector of claim 97, wherein said control functionality is operable to assign a role of active communicator to whichever one of a device associated with said infra-red port and the device associated with said remote port is a fixed device.

101. The passive modulator and retro-reflector of claim 93, wherein said modulator comprises a capacitive microphone.

102. The passive modulator and retro-reflector of claim 93, wherein said modulator comprises a piezoelectric transducer.

103. The passive modulator and retro-reflector of claim 93, wherein said retro-reflector comprises a reflecting layer.

104. The passive modulator and retro-reflector of claim 93, wherein said retro-reflector comprises a liquid crystal layer.

105. The passive modulator and retro-reflector of claim 103, wherein said reflecting layer comprises stripes of reflecting material interspersed with non-reflecting material.

106. The passive modulator and retro-reflector of claim 103, wherein said reflecting layer is superimposed on a second layer comprising stripes of non-reflecting material interspersed with transparent material.

107. The passive modulator and retro-reflector of claim 106, wherein said modulator comprises a piezoelectric actuator associated with one of said layers to cause relative motion between said reflecting layer and said second layer.

108. The passive modulator and retro-reflector of claim 107, wherein said piezoelectric actuator is located laterally of said one of said layers.

109. The passive modulator and retro-reflector of claim 107, wherein said piezoelectric actuator is associated with said reflecting layer.

110. The passive modulator and retro-reflector of claim 107, wherein said piezoelectric actuator is arranged to cause bending of said one of said layers.

111. The passive modulator and retro-reflector of claim 110, wherein said piezoelectric actuator is associated with said reflecting layer.

112. The passive modulator and retro-reflector of claim 93, wherein said receiver, and said retro-reflector together comprise a lens having a focal point, and a mirror, and wherein said mirror is located at said focal point.

113. The passive modulator and retro-reflector of claim 112, wherein said retro-reflector comprises said mirror and said modulator comprises a control mechanism associated with said mirror for causing vibrations of said mirror.

114. The passive modulator and retro-reflector of claim 112, wherein said modulator comprises polarizing filters located in front of said mirror, said polarizers being controllable to variably polarize incident radiation.

115. The passive modulator and retro-reflector of claim 112, wherein said modulator comprises an aperture controller for controlling the aperture of said lens.

116. The passive modulator and retro-reflector of claim 115, wherein said aperture controller comprises a first layer having stripes of transparent material interspersed with absorbing material.

117. The passive modulator and retro-reflector of claim 116, wherein said aperture controller further comprises a second layer having stripes of non-reflecting material interspersed with transparent regions, said first and said second layers being superimposed on each other.

118. The passive modulator and retro-reflector of claim 115 wherein said aperture controller comprises an LCD unit.

119. The passive modulator and retro-reflector of claim 93, wherein said receiver, and said retro-reflector together comprise a lens having a focal point, and a liquid crystal panel and wherein said liquid crystal panel is located at said focal point.

120. The passive modulator and retro-reflector of claim 119, wherein said modulator comprising control circuitry associated with said LCD panel to provide variable reflectance in said modulator.

121. The passive modulator and retro-reflector of claim 93, wherein said retro-reflector comprises a corner cube.

122. The passive modulator and retro-reflector of claim 93, wherein said modulator comprises a MEMS optical switch.

123. The passive modulator and retro-reflector of claim 122, wherein said MEMS optical switch is a thermal effect MEMS optical switch.

124. The passive modulator and retro-reflector of claim 122, wherein said MEMS optical switch is an electrostatic force MEMS optical switch.

125. The passive modulator and retro-reflector of claim 93, wherein said modulator comprises a liquid crystal panel arranged in patterns of reflecting and non-reflecting regions, said panel being controllable to rearrange said patterns.

126. The passive modulator and retro-reflector of claim 93, located in a sensor device, for providing communication between said sensor device and said remote port.

127. The passive modulator and retro-reflector of claim 126, said sensor device being an elongated marker type sensor device.

128. An infra-red based remote control unit for remotely controlling a device, the unit comprising:

an infra-red receiver for receiving infra red radiation from said device,

a modulator, associated with said receiver, for modulating said infra red radiation with control data for said device, and

a reflector, associated with said modulator, for redirecting said modulated infra-red radiation to carry said modulated radiation to said device, thereby to passively control said device.

129. An infra-red relay unit for relaying a communicating using infra red to a remote port, the infra-red relay unit comprising:

an infra-red receiver for receiving modulated infra red radiation from one source and unmodulated infrared radiation from another source,

a modulator, associated with said receiver, for modulating said unmodulated infra red radiation with data carried by said modulated radiation to form a relay beam, and

a reflector, associated with said modulator, for redirecting said relay beam to carry said modulated radiation to said remote port, thereby providing a passive relay link.

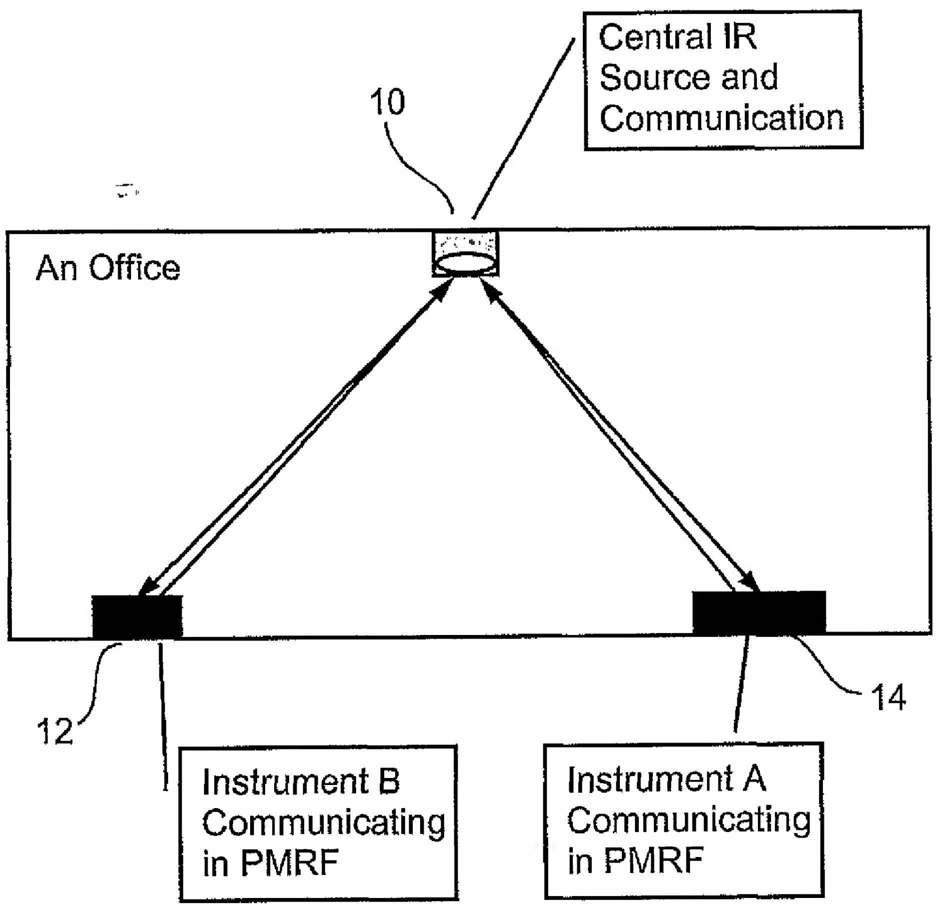

Central IR
Source and
Communication
10
An Office
12
14
Instrument B
Communicating
in PMRF
Instrument A
Communicating
in PMRF

Fig. 1

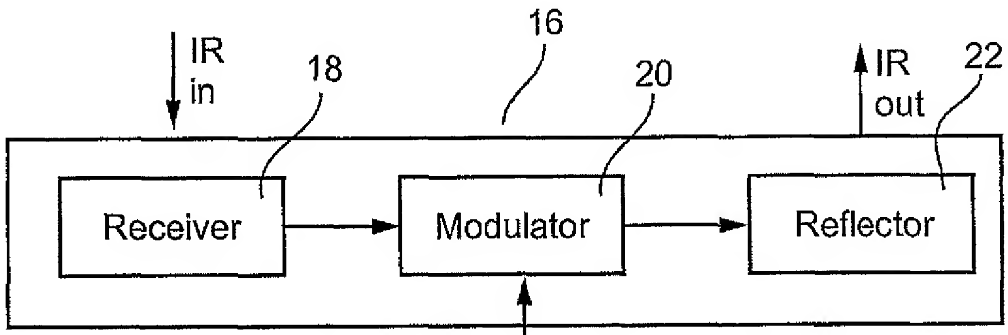


Fig. 2

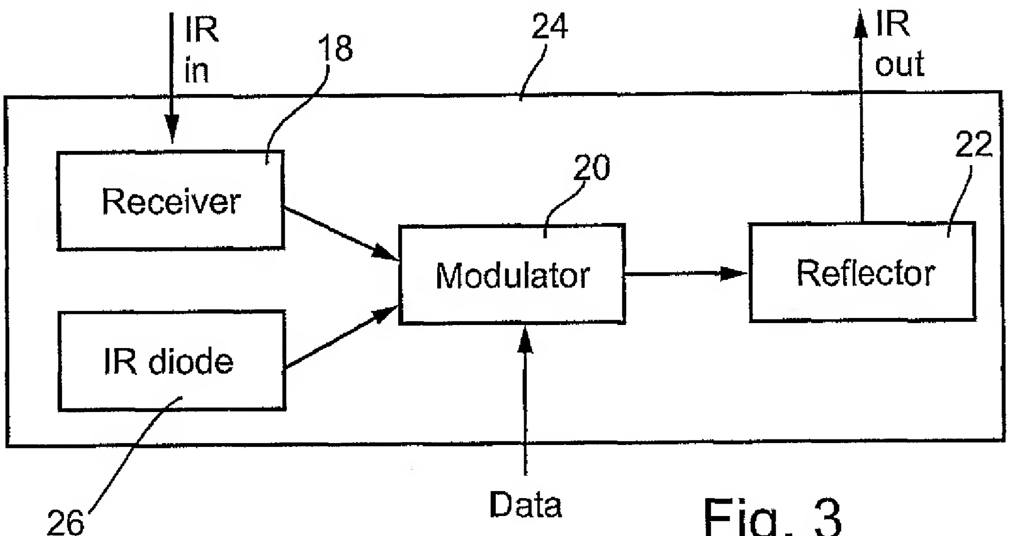


Fig. 3

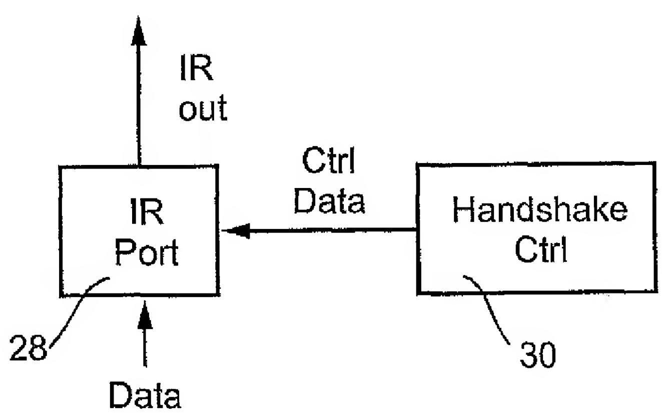


Fig. 4

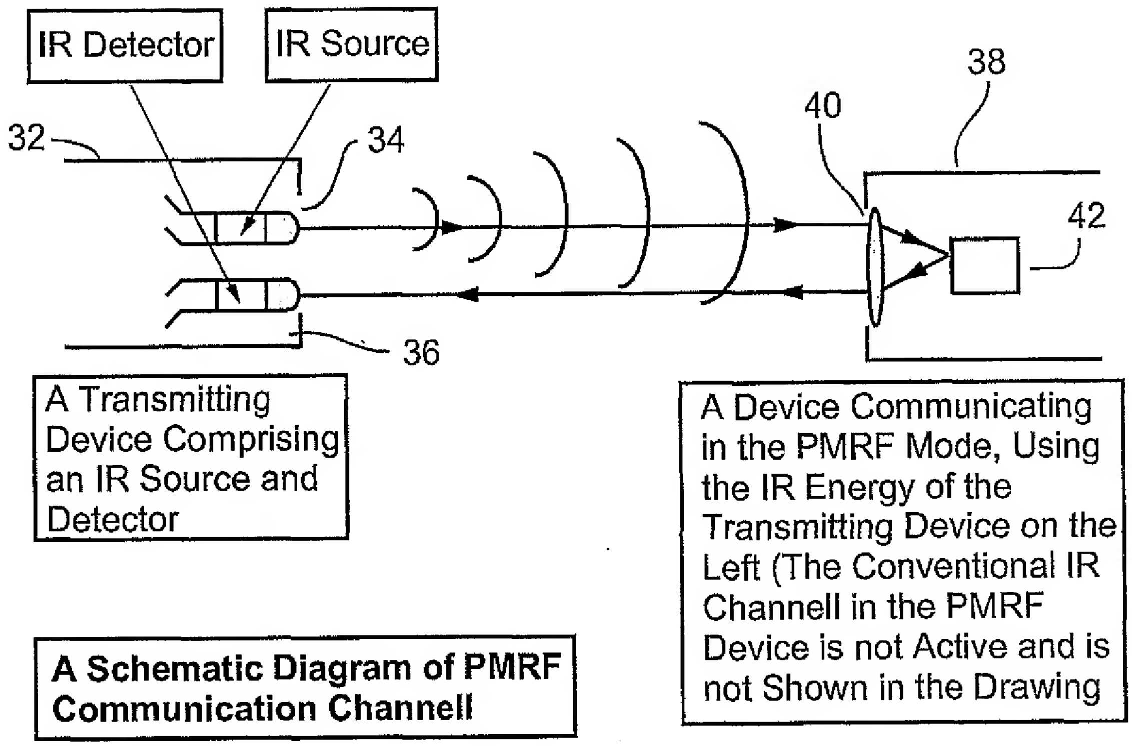

IR Detector
IR Source
32
34
36
38
40
42
A Transmitting Device Comprising an IR Source and Detector
A Device Communicating in the PMRF Mode, Using the IR Energy of the Transmitting Device on the Left (The Conventional IR Channell in the PMRF Device is not Active and is not Shown in the Drawing
A Schematic Diagram of PMRF Communication Channell

Fig. 5

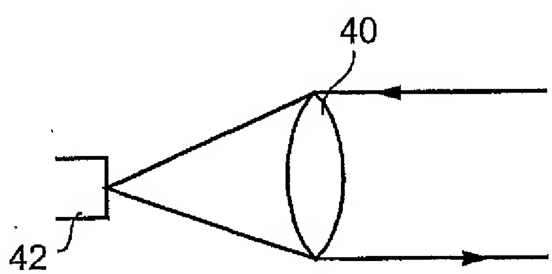
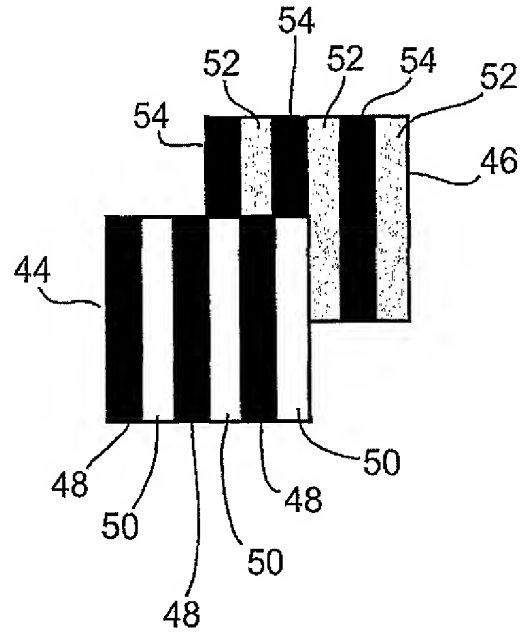

40
42

Fig. 6


54
52
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50
48

Fig. 7

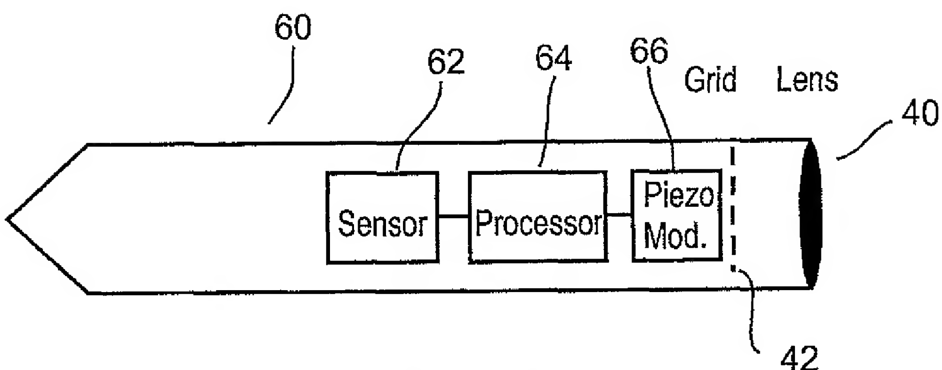
60
62
64
66
Grid
Lens
40
Sensor
Processor
Piezo
Mod.
42

Fig. 8

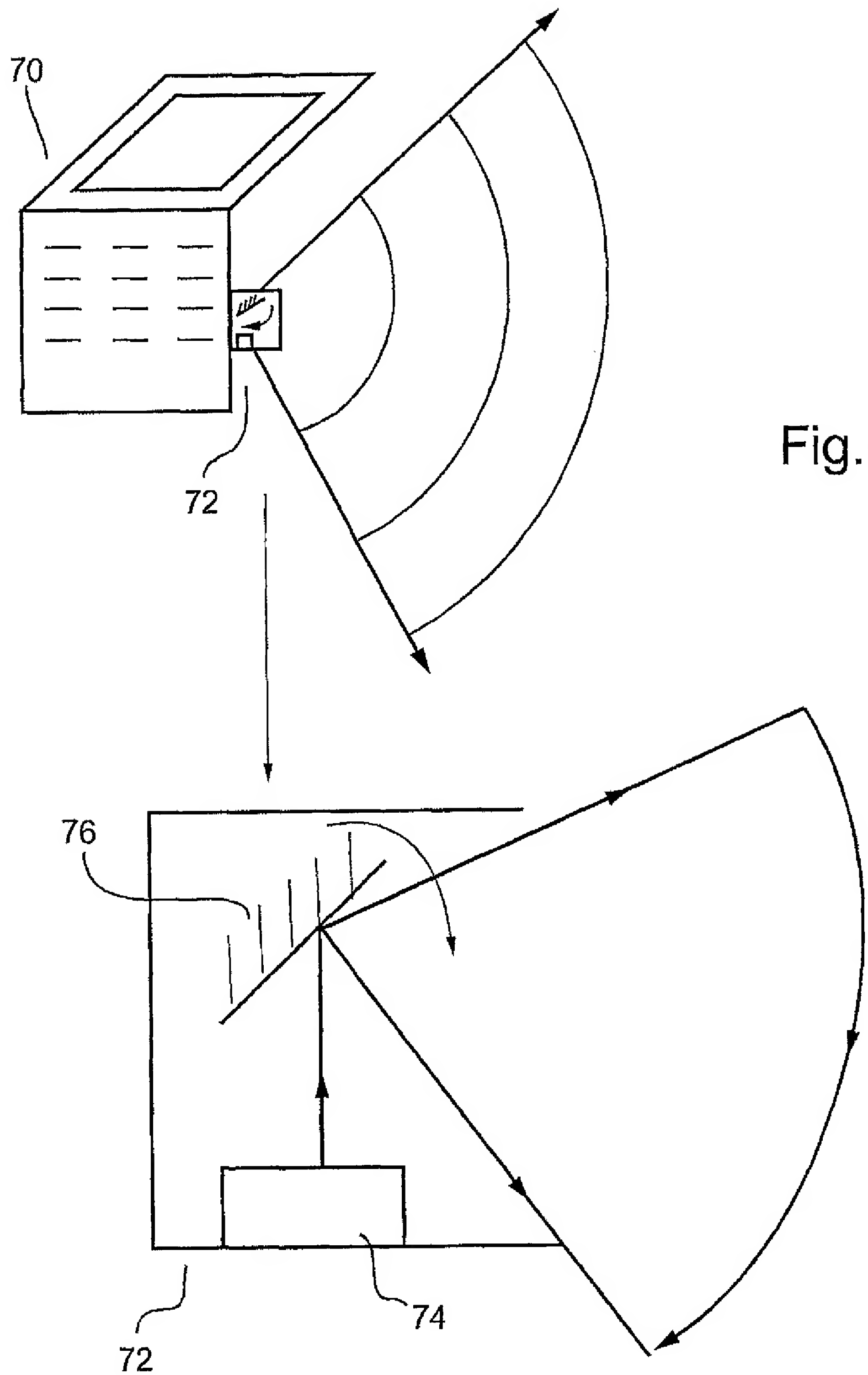

Fig. 9

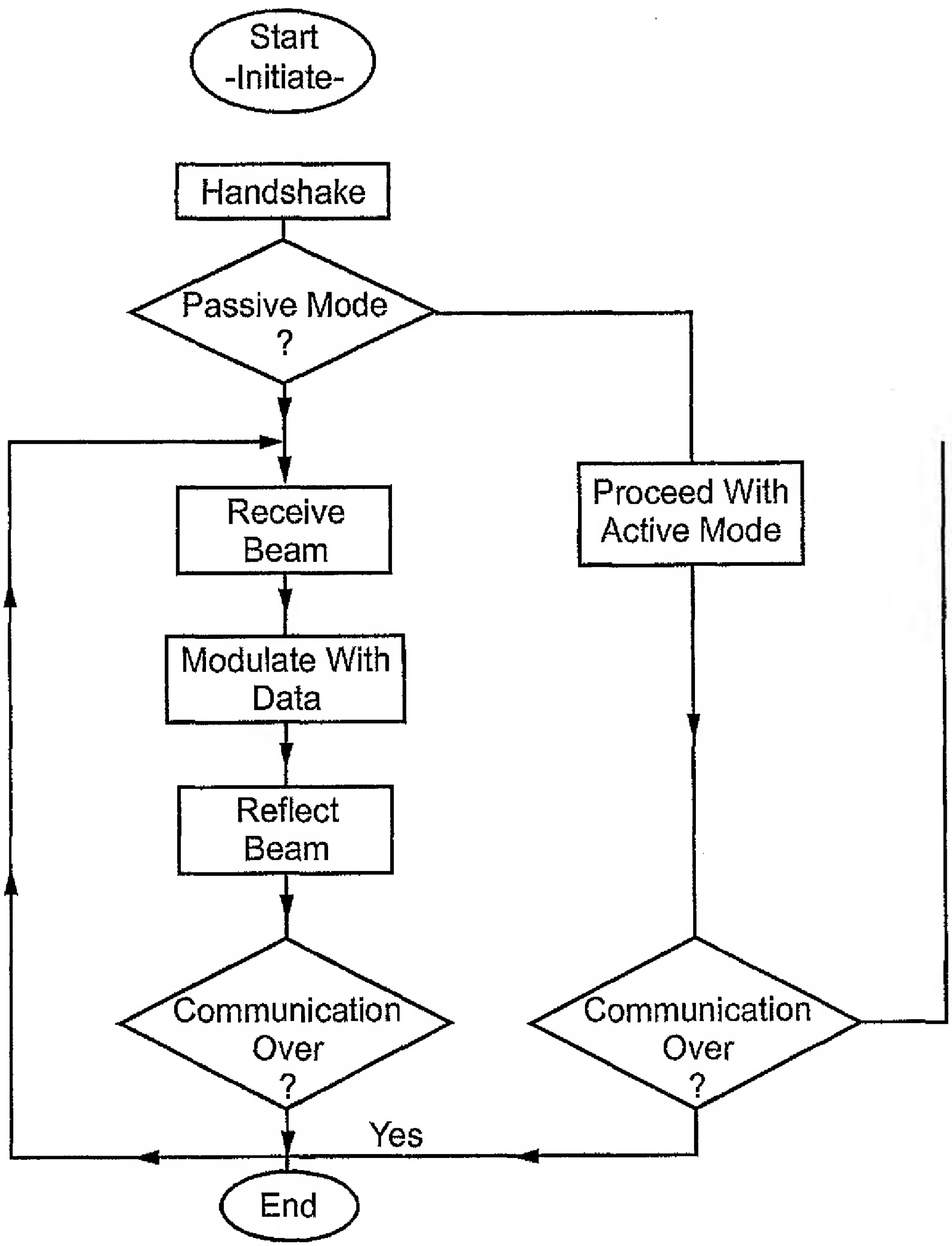
Start
-Initiate-
Handshake
Passive Mode
?
Proceed With
Active Mode
Receive
Beam
Modulate With
Data
Reflect
Beam
Communication
Over
?
Communication
Over
?
Yes
End

Fig. 10